

Vegetation of Great Island, Three Kings Group

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In May, 1946, the Department of Internal Affairs, in answer to representations made by Mr. A. W. B. Powell, then Acting Director of the Auckland Museum, sent a party of deer-stalkers to Great Island to destroy the goats whose presence threatened with extinction many of the plants and animals peculiar to the locality. This commendable action brought to an end a long period of modification of the plant cover by man and by stock liberated upon the island. As Great Island is now uninhabited and rarely visited, it should remain free from further interference and undergo changes of considerable interest ecologically. The purpose of this paper is to trace briefly the past history of the vegetation, and to record its condition immediately prior to removal of the goats. Unfortunately, owing to the difficulties of access it is based on but limited study—two half-days ashore in February, 1934, and a week in November, 1945. For both these opportunities I am indebted to officers of the Auckland Museum. I have in addition received special assistance from Mr. E. G. Turbott, who placed at my disposal much information and many photographs obtained during the visit of the goat-shooting party. Mr. Turbott took advantage of his fairly long stay on the island to establish permanent quadrats. These are described in an accompanying paper, and their existence will enable future development of the plant cover to be traced with greater accuracy than would be possible on the basis of this account alone.

HISTORY OF ALIEN FACTORS AFFECTING THE VEGETATION.

Maoris were living on Great Island at the time of its discovery by Tasman in 1643 (Tasman, 1898). His men did not land, but saw cultivated plots in the Tasman Valley and between thirty and thirty-five persons. The island was still inhabited in 1772 and was at this date described by Crozet as grassy with groves of bushes (Roth, 1891). About twenty years later yet another passing mariner saw signs of occupation (Labillardière, 1799), and it is significant that in 1810 a trading party at the Bay of Islands, apprehensive of trouble with the natives, contemplated taking refuge in the group because they believed goats and hogs to be available there for food (McNab, 1908). Other evidence of the presence of goats about this time is cited by Cheeseman (1887)* who records an instance of goat skins being obtained from Great Island.

* Cheeseman's statement that the "Betsey" survivors lived on the Three Kings is not supported by McNab's (1914) account of their adventures.

Maori occupation ended about 1840 (Cheeseman, 1887). It thus lasted at least intermittently for two centuries or longer, and the inhabitants kept goats and probably pigs in the latter years. Moreover, as a place of refuge from threat of massacre in tribal wars, the island was probably often overpopulated and its resources utilised to the utmost. This appears to have been the case at the time of Puckey's visit in 1835 (Puckey, 1836). It is reputed at one time to have supported about a hundred persons (Cheeseman, 1887).

After departure of the Maoris occasional visitors burnt patches of the island. Areas that appear thus affected are the predominantly grassy land south-west of the Tasman Stream, the vicinity of the cast-away depot, and the eastern tip of the island. According to contemporary press accounts the second of these was fired in 1902 by survivors of the "Elingamite."

The main factor modifying the vegetation in the present century has, however, been the goats. These were not, it seems, survivors of the Maori settlers' livestock, which was apparently too highly prized to be left behind on their departure.* This is indicated by the abundance of highly palatable plants (e.g., *Angelica rosaefolia*† and large-leaved *Coprosma* species) when the island was first described botanically—by Cheeseman, who landed in 1887 and again in 1889. It is confirmed by the fact that in order that there might be food for possible castaways it was deemed necessary to restock the island with goats at this time, and four of these animals were landed from the Government steamer on the occasion of Cheeseman's second visit.‡ Cheeseman must have been aware of this, but apparently did not then appreciate the damage goats could do to the native vegetation so saw no reason to record their arrival. Further evidence of this attitude is provided by this author's (1887a) account of the vegetation of Macauley I. The grassy nature of the plant cover appears to have surprised him, yet he makes no mention of the herd of goats on which that peculiarity depends (Oliver, 1909).

These four goats appear to have multiplied with great rapidity. A member of the "Elingamite" salvage party* states that these animals were plentiful by 1903, Fraser (1909) estimated their number at 300 in 1928, and in 1934 the island seemed to the present author to have been supporting about a maximum population. The number destroyed in 1946 was 393.

THE PRIMITIVE FOREST.

Even at the time of Cheeseman's visits the forest of Great Island was therefore far from primitive. The best guides to its original composition are the vegetation of other islands of the group and the few groves of mixed trees which occur on Great Island itself. In connection

* This conclusion may be incorrect—see appendix.

† Major R. Wilson informs me that in his experience this is the first species to disappear where goats enter new country.

‡ I am indebted to the Secretary of Marine for furnishing this information from departmental records. Two goats were also landed on S.W. Island (called Western King by the Marine Department), but these apparently failed to establish themselves (Buddle, 1947).

* Mr. D. G. Mathew, of Auckland.



Photo. G. T. S. Baylis.
Specimen in Auckland Museum, collected by G. T. S. Baylis, 1st December, 1945.
Photo. B. W. Hall.



Brachyglottis arborescens, Great Island.

with the former it is necessary to consider the extent to which they also may have been modified. Despite difficulty of access and lack of permanent water there is evidence of Maori occupation of these islets (Buddle, 1948). Nevertheless, all of them large enough to support trees (North-East, South-West, and West* Islands) bear a type of forest wholly different from that of Great Island and one in which endemic and semi-endemic species are prominent. It seems safe to assume that this is virtually a primitive community, interference by the Maori having in the absence of goats been quite transitory in its effects—and probably far less than that to which the comparatively hospitable Great Island was subject.

My own study of the forest on the smaller islands has been limited to what little can be accomplished from a boat offshore, and the following description depends largely on the observations made by Cheeseman (1890) and by Buddle (1947). The dominant tree is for the most part the puka (*Meryta sinclairii*), which tends to form pure stands. On both the West and North-East Islands, however, its place is taken over small areas by the pohutukawa (*Metrosideros excelsa*). The chief subdominant is the large-leaved kawakawa (*Macropiper excelsum* var. *major*). *Cordyline australis*, *Paratrophis smithii*, *Coprosma macrocarpa* and *Melicope ternata* probably rank in this category also. The principal forest floor herbs are the ferns *Asplenium lucidum* and *Pteris comans*.

As all members of the group are similar geologically, this type of forest presumably occupied on the main island stations similar to that in which it still occurs on the smaller ones. These are the steep faces between about 200 and 600 feet above the sea which have some covering of soil. The community may have grown further inland, for it has no opportunity of demonstrating its capacity for this on the small islands.* The evidence afforded by relics of the primitive vegetation persisting on Great Island itself suggests that this was not the case, but rather that wherever there was more shelter than the small islands afford and a fair depth of soil, Great Island carried a mixed coastal or semi-coastal forest with the same dominant species as may be found on the mainland and other coastal islands (Cockayne, 1928; Cranwell & Moore, 1935; Oliver, 1925). These included *Metrosideros excelsa*, *Litsaea calicaris*, *Hedycarya arborea*, *Vitex lucens*, *Sideroxylon novozelandicum*, *Corynocarpus laevigata*, *Olea apetala* and *Melicytus ramiflorus*. Distinction would be given to the community, however, by the large liane *Tecomanthe speciosa* growing along the streams and by the smaller trees, since in this category the island presents several species which are locally endemic, namely, *Paratrophis Smithii*, *Suttonia dentata*, *Brachyglottis arborescens*, *Coprosma macrocarpa*,* *Pittosporum Fairchildii*, *Alec-*

* Cheeseman (1890) describes West Is. as "little more than a bare rock." This is its northern aspect, but from the south-east *Phormium* is visible in some quantity and also both pohutukawa and puka.

* It is noteworthy that in the Hen and Chickens Islands, the only other locality in which *Meryta Sinclairii* is indigenous, it is a member of mixed coastal forest wherein it forms occasional consociations all of which are near the sea (Cranwell and Moore, 1935).

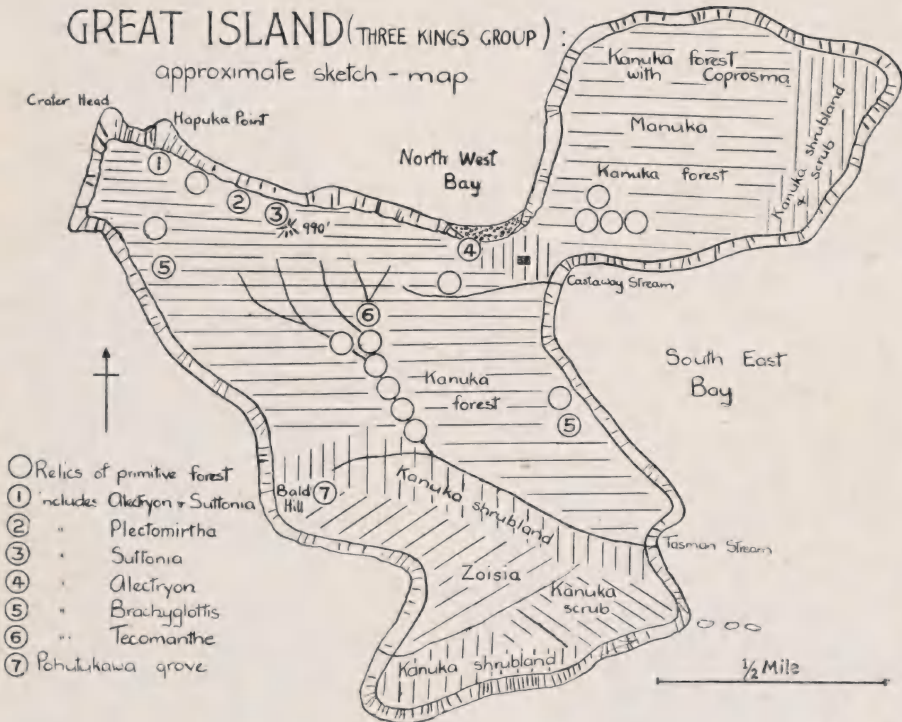
* Oliver (1935) considers that this species includes forms found outside the Three Kings Group. However, the large fruit of the Three Kings plant is perhaps distinctive.

tryon grandis and *Plectomirtha baylisiana*. The extent to which these grew with the larger trees as sub-dominants is uncertain, however. Of the two that survive in some numbers one (*Paratrophis*) suggests by its distribution and shade tolerance that it did so, the other (*Brachyglottis*) that it did not, pointing rather to the existence of a third type of forest in windswept and stony places above the *Meryta* belt. In this these small trees would have been dominant, accompanied no doubt by non-endemic species, notably *Hiemerliodendron* (*Pisonia*) *brunoniana*, *Melicope ternata* and *Cordyline australis*.

Only one specimen of *Meryta* has ever been found on Great Island. According to Messrs. Turbott and Bell, by whom it was discovered in May, 1946, the tree was little more than a seedling and rooted on an inaccessible cliff ledge. The principal species accompanying it on other islands, *Macropiper excelsum*, does, however, figure in Cheeseman's list of 1887; Since *Meryta* is a very thin-barked tree and its family, the *Araliaceae*, is highly palatable (Aston, 1911), its virtual absence now does not invalidate the arguments in favour of its having been plentiful.

THE PRESENT VEGETATION.

The most striking feature of Great Island today is the uniform appearance of the plant cover. *Leptospermum ericoides*, the kanuka, is the sole dominant in nearly all situations. This species appears to be



Vegetation of Great Island in 1945.

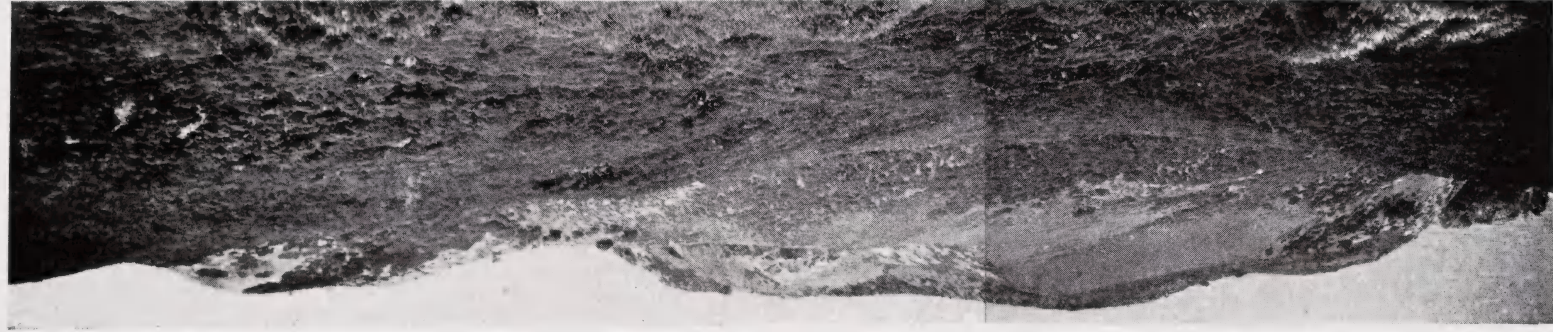


Fig. 1. View south from head of Tasman Valley. Tasman Bay (left), South Point (centre) and Bald Hill (right).



Fig. 2. Northern coastline from the head of N.W. Bay (left) to Crater Head.

characteristic of old Maori clearings on the coastal islands of North Auckland (Oliver, 1925; Cranwell & Moore, 1935; Hamilton, 1936). On Great Island it shows much plasticity of growth form, on the basis of which it is convenient to subdivide the kanuka communities into forest, shrubland and prostrate scrub, but between these types there is no sharp distinction.

(1) Kanuka Forest (Figs. 6, 8, 9).

What is commonly called "tall tea-tree" is the principal plant association, best developed in the valleys but extending even on to the stony soil of very steep faces which form the upper part of many of the cliffs. The only species with any claim to be considered co-dominant are the cabbage tree (*Cordyline australis*) and manuka (*Leptospermum scoparium*), but specimens of both are so far between that they are of no moment except about the centre of the eastern limb of the island where manuka occurs in almost pure stands over a small area. This manuka appears to be undergoing replacement by kanuka (Fig. 8), and in this connection it should be noted that Cheeseman (1897) gives the impression that *L. scoparium* was the principal species at the time of his visits. This could be true of areas like that round the present castaway depot which have been burnt and have regrown since, but judging by the manifest age of the kanuka in the Tasman Valley the ambiguous term "tea-tree" in Cheeseman's accounts must often mean *L. ericoides*, a species which he certainly collected.

The kanuka is slender and rarely above twenty feet in height except in parts of the Tasman Valley where it shows some approach to the size it has attained in old Maori clearings on Taranga Island (Cranwell and Moore, 1935). Epiphytes are lacking and lianes rare. Only two shrubs, *Coprosma rhamnoides* and *Myoporum laetum*, occur as subdominants and both of these have a limited distribution, the former being plentiful only beneath wide-spaced senescent trees on the eastern limb of the island (Fig. 9), and the latter occasionally forming a straggling under-scrub within a few yards of the clifftops.

Apart from occasional specimens of wharangi (*Melicope ternata*) which seem to resist destruction for a time (Turbott, 1948), there are no seedlings of woody plants on the forest floor. Where the canopy is dense, raw humus formed from twigs and leaves of kanuka accumulates and supports little but *Dichondra repens*. Usually the roof is less close and *Carex testacea* forms conspicuous tussocks except on rich damp soil where *C. virgata* replaces it. *Scirpus nodosus*, a plant truly ubiquitous on the island, is also plentiful. Between these larger species is a more or less continuous turf in which most of the small grasses and herbs listed at the end of this article are found.

Kanuka forest is undoubtedly a sub-climax, its persistence depending on elimination of seedlings of the climax trees by goats. As the climax species are now very rare it must have been many years since their seedlings had any tendency to appear in quantity. Young plants of kanuka like the adult are unpalatable, but since they are intolerant of shade they appear only after death of the old trees. *Carex testacea* and other species of the floor are not deleteriously affected by loss of shade.

however, and their persistence in glades which are opening up in old kanuka about the head of the Tasman Valley is delaying re-establishment of that forest. Patches dominated by this sedge recall on a small scale dominance by the grass *Macrolaena avenacea*, which has been induced by stock on Te Moehau (Moore and Cranwell, 1934). In much of the eastern limb of the island the kanuka is dying when only about ten feet high. There is little humus and *Carex testacea* is uncommon. The ground is left bare apart from a sparse growth of *Scirpus nodosus*, a few windshorn bushes of young kanuka and mosses* (Fig. 10).

(2) Kanuka Shrubland.

In places the kanuka is too low in stature to be termed forest and must be regarded as shrubland. Excluding small patches on very shallow soil these areas are clearly only a stage of growth of the forest on land comparatively recently burnt, i.e., near the castaway depot, on the southern side of the lower Tasman Valley, and near the eastern tip of the island. Except for the fact that *Carex testacea* does not seem to establish itself until there has been some accumulation of humus, the accompanying species are much as in the forest.

The growth rate is appreciable. In 1934 the shrubland about the castaway depot was not above four feet tall, so that the building, which is some eight feet in height, was a conspicuous landmark. Eleven years later it was completely hidden from most angles (Figs. 4 and 5).

(3) Kanuka prostrate scrub.

There are, however, areas in which the kanuka is so modified in habit that there is little indication that it will ever attain the tree form. The plants are low mats spreading close to the ground, their branches save for the leafy tips buried in silt and humus. Adventitious roots occasionally appear. In many cases mats several feet across are nowhere more than three inches in height; others may rise to about a foot at the centre. This low habit is universal over the windswept face south of the mouth of the Tasman Stream. A closely grazed turf of *Zoisia matrella* occupies the intervening spaces, and *Scirpus nodosus* grows through and between the mats (Fig. 11).

(4) *Zoisia* sward.

Much of the land south of the Tasman Stream is covered by a sward of *Zoisia matrella* through which creeps a sparse growth of *Centella asiatica*. Scattered upon it are pieces of charred wood, but as there are no stumps the association destroyed by fire must at most have been but shrubby (Fig. 12). The date of burning is difficult to fix. At the time of Cheeseman's (1890) visits this slope was grassy.* It seems likely that in the intervening period kanuka established itself on the area and was in due course fired. It is now extending slowly upwards again from the valley bottom, gaining a foothold mainly in colonies of *Scirpus nodosus* with which the sward is dotted, but some times independently.

* The principal species has in the absence of fruit been provisionally determined as *Campylopus bicolor* (Hornsch.) Hook by Mr. G. O. K. Sainsbury. Others are *C. introflexus* (Hedw.) Mitt., *Leptodontium interruptum* (Mitt.) Broth. and *Debera nutans*, Hedw.

* Cheeseman did not examine this area closely, which is sufficient explanation of the absence of *Zoisia* from his lists.



Fig. 3. View of the eastern limb of Great Island from the head of Castaway Valley, North East Island in distance. (E. G. Turbott.)

Figs. 4 and 5. The depot and Castaway Valley from the same point in 1934 and in 1946. (E. G. Turbott.)

Zoisia was probably the pioneer inhabitant of the area when it was left bare after fire. Its ability in this respect is well shown on Bald Hill, † where there is at present about half an acre of bare soil much eroded by wind and rain. It seems to have arisen following death of pohutukawa forest, of which a remnant still remains immediately adjacent—a favourite camping place for goats and entirely devoid of undergrowth. *Scirpus nodosus* and *Cladium junceum* are extending slowly on to the bare area from its margins, the former accompanied as a rule by *Zoisia*, the latter growing alone. Of these colonisers the grass only is sufficiently aggressive to establish itself in the midst of the eroded land. Here it builds up hummocks resembling those formed by sandbinders on a dune (Fig. 13).

Oliver (1909) records on Macauley Island a comparable instance of a sward-forming grass displacing a woody plant (*Myoporum laetum*) after burning and in the presence of goats. In this case the grass is an exotic (*Polypogon monspeliensis*). Neither *Zoisia* nor *Leptospermum* are represented in the Kermadec flora.

(5) Cliff Vegetation.

Fissures and ledges on the sea-cliffs which are inaccessible to goats support species no longer found elsewhere. Commonest are the rock lily (*Arthropodium cirrhatum*), *Cyperus ustulatus*, and the endemic *Hebe insularis*, but a good many others, indicated by (i) in the list at the end of this article, still have a foothold here. Elsewhere, destruction of these species has left much bare rock and increased the accumulation of scree material, especially at the head of North-West Bay. The only plant at present taking advantage of the extension of this type of habitat is the ngaio (*Myoporum laetum*). The low, sprawling form common on coastal islands of North Auckland (Cockayne, 1928; Cranwell and Moore, 1935; Oliver, 1935) has occupied some of the screes above the landing place in North-West Bay and on the eastern side of Hapuka Pt.

(6) Remnants of Original Forest.

Destruction of most of the original forest can undoubtedly be ascribed to Maori settlers, who under force of circumstances cleared and cultivated surprisingly inhospitable places. So it was that even when Cheeseman landed the vegetation was predominantly kanuka. The most conspicuous relic of climax forest that survives is a small grove of pohutukawa below Bald Hill, apparently the remains of a consociation of that species. The pohutukawa is widely scattered over cliffs and steep faces elsewhere, but only as single meagre specimens or small groups. This grove is the only instance of trees other than *Leptospermum* occupying land capable of cultivation. Other relics of the old forest are confined to the banks of the Tasman Stream (Fig. 7), and patches of very rocky ground elsewhere—places which either escaped clearing or were permitted to begin regeneration sufficiently early for the process not to have been arrested by the depredations of the goats. Along the Tasman Stream these remnants form a very broken chain of small groves. Of those more isolated, the clump of twelve trees in Castaway Valley affords a good example illustrating well the character-

† Cheeseman's (1890) "Knoll covered with pohutukawa trees."

istic diversity of species which contrasts strongly with the monotony of the surrounding kanuka. In this case there is a puriri (*Vitex lucens*), a mangeo (*Litsaea calicaris*), a wharangi (*Melicope ternata*), three small trees each of mahoe (*Melicytus ramiflorus*) and cabbage-tree (*Cordyline australis*), two of milk-tree (*Paratrophis Smithii*) and one of pigeonwood (*Hedycarya arborea*). It is on the flora of such fragments that the list of species presumed to have dominated the original mixed coastal forest is based. One cannot, of course, be satisfied that they are fully representative.

CHANGES SINCE 1889.

When Cheeseman made his brief examinations of Great Island in 1887 and 1889, the vegetation was much less monotonous than it is today. For fifty years it had been undisturbed* by alien factors and among the predominating *Leptospermum* constituents of a mixed coastal forest seem to have been re-appearing, but were as yet of small size ("the tea-tree . . . is mixed with shrubs or small trees, but there is nothing approaching the dimensions of an ordinary forest tree"). † Of woody species now so rare that protracted search of the whole island can locate not more than a half-dozen specimens the following were noted by Cheeseman at least more than once during his hurried visits, most of them being actually termed plentiful—*Coprosma macrocarpa*, *Corynocarpus laevigata*, *Gemlostoma ligustrifolium*, *Hedycarya arborea*, *Hiemerliodendron* (*Pisonia*) *brunoniana*, *Pittosporum Fairchildii*, *Pseudopanax Lessonii*. This regenerating forest was eaten out by the goats landed in 1889. They also virtually if not entirely destroyed *Colensoa physaloides* and the forest-floor ferns except *Doodia media*. Plants other than trees then plentiful on hillsides and now absent save perhaps in inaccessible places were *Phormium tenax*, *Arundo kakaho*, *Pteridium esculentum*‡ and *Leucopogon Fraseri*. The present barrenness of the cliffs above the landing place appears to be due principally to the destruction of *Sicyos angulata*, *Angelica rosaefolia*, *Phormium tenax*, *Arundo kakaho*, *Disphyma* (*Mesembryanthemum*) *australe* and *Apium prostratum*, all of which no longer occupy this particular station.

In an accompanying paper Oliver (1948) records all the vascular plants that have at any time been noted or collected in the Three Kings Islands. The list at the end of this article shows the state of the flora in 1945-1946. A comparison reveals that 25 species which had been recorded from Great Island itself some time between 1887 and 1934 could no longer be located in the year prior to the removal of the goats. They are: *Acianthus fornicatus* R. Br., var. *Sinclairii* (Hook. f.) Hatch; *Calystegia sepium* (L.) R. Br.; *C. tugariorum* (Forst. f.) R. Br.; *Cladium teretifolium* R. Br.; *Clematis parviflora* A. Cunn.; *Coprosma robusta* Raoul.; *C. australis* (A. Rich.) Robinson; *Cyclosorus pennigera* (Forst. f.) Copel.; *Deyeuxia filiformis* (Forst. f.) Hook. f.; *Entelea arborescens* R. Br.; *Epilobium nummularifolium* A. Cunn.; *Gnaphalium japonicum* Thunb.; *Haloragis erecta* (Murr.) Schind.; *Hypolepis tenui-*

* Perhaps not wholly so—see appendix.

† (1887) p. 143.

‡ Still seen occasionally on the eastern limb of the island.



Fig. 6. Interior of kanuka forest, Tasman Valley.

Fig. 7. Grove of mixed trees beside Tasman Stream: *Melicytus ramiflorus*, *Cordyline australis*, *Leptospermum ericoides*, *Paratrophis smithii*, *Cyathea medullaris*.

folia (Forst. f.) Bernh.; *Leucopogon Fraseri* A. Cunn.; *Lycopodium volubile* Forst. f.; *Myosotis spathulata* Forst. f.; *Polystichum Richardi* (Hook f.) Sm.; *Pseudopanax Lessonii* (D.C.) Koch.; *Pteris tremula* R. Br.; *Siegesbeckia orientalis* L.; *Tillaea sicberiana* Schultz; *Unicinia unciniata* (L.) Kirk. If one accepts appearance in the list given in Cheeseman's second paper, unaccompanied by any indication as to whether the record relates to Great Island or to South-West Island, as being in effect a record for Great Island (as is likely in the majority of cases), then this list would be extended by the addition of a further 27 names. Moreover, it should be borne in mind that approximately half of the species admitted in the present paper as still being present on the island are reduced to a very few specimens or restricted to places inaccessible to goats.

In view of the brevity of Cheeseman's surveys it is impossible to be sure whether or not there has since been some addition to the flora to compensate for this loss. *Zoisia matrella* is not in Cheeseman's lists, but this seems likely to be a mere omission—the fact that the island was divided 56 years ago between *Leptospermum* and grass areas much as it is today suggests that no ecologically significant species has established itself in the interval.

LIST OF VASCULAR PLANT GROWING ON GREAT ISLAND, 1945-1946.

The following list is based mainly on my collection made in November, 1945, but a few records depend on specimens obtained in May, 1946, by the goat-shooting party and forwarded to me by Mr. E. G. Turbott.

I am indebted to Dr. H. H. Allan for examining members of difficult genera and to Miss B. Molesworth for assistance in referring to the Cheeseman herbarium. Dr. W. R. B. Oliver kindly placed his determinations of all available Three Kings herbarium material at my disposal prior to publication, and the names adopted in the following list conform with his opinions. The material on which the list is based is lodged in the Auckland Museum.

Of the 118 species named, 21 (i) can be found only in places inaccessible to goats, 40 (r) are rare (in most cases the number of individual plants known to exist is given), 31 (o) are found only occasionally, so that maintenance of plant cover really depends on the remaining 26, which are common (c) or abundant (a). It is remarkable, in view of the long period over which the vegetation has been modified by exotic agencies, that only four of these twenty-six plants are definitely not indigenous in the New Zealand region, and the ecological significance of these is limited by the fact that they are all small annual herbs (*Aira praecox*, *A. caryophyllea*, *Cotula australis* and *Vulpia dertonensis*). Species which are members of New Zealand's naturalised flora are distinguished in the following list by an asterisk.

Adiantum affine Willd. (r)

Adiantum hispidulum Swartz. (o)

* *Aira praecox* L. (a)

* *Aira caryophyllea* L. (a)

Alectryon grandis Cheesem. (r-2)

- Angelica rosaeifolia* Hook. (i)
Apium prostratum Lab. (i)
Arundo kakaho Steudel (i)
Arthropodium cirrhatum (Forst. f.) R. Br. (i)
Asplenium obtusatum Forst. (i)
Asplenium flaccidum Forst. (i)
Brachyglottis arborescens Oliver. (r-35)
* *Bromus mollis* L. (o)
Blechnum procerum (Forst. f.) Anders. (i)
Blechnum norfolkianum (Hew.) C. Chr. (r)
Caladenia carnea R. Br. var. *minor* (Hook. f.) Hatch (o)
Callitriche Muellieri Sond. (r)
Cardamine heterophylla (Forst. f.) Schulz. (r)
Carex breviculmis R. Br. (c)
Carex testacea Boott. (a)
Carex lucida Boott. (o)
Carex virgata Hook. f. (c)
Carex Forsteri Wahl. (r)
Centipeda orbicularis Lour. (o)
Centella asiatica (L.) Urban (a)
* *Cerastium caespitosum* Gilib. (r)
* *Cirsium lanceolatum* (L.) Hill (o)
Cladium junceum R. Br. (o)
Cladium rubiginosum (Forst. f.) Druce (o)
Clematis indivisa Willd. (r-4)
Colensoa physaloides (A. Cunn.) Hook. f. (r)
Coprosma macrocarpa Cheesem. (r-4)
Coprosma repens A. Rich. (i)
Coprosma rhamnoides A. Cunn. (o)
Corynocarpus laevigata Forst. (r-7)
Cordyline australis (Forst. f.) Hook. f. (c)
* *Cotula australis* (Lieb.) Hook. f. (c)
Cyathea medullaris Swartz. (r)
Cyperus ustulatus A. Rich. (i)
Danthonia semiannularis R. Br. (c)
Davallia Tasmani Cheesem. (i)
Deyeuxia crinita (L.) Zotov. (c)
Dianella intermedia Endl. (r)
Dichondra repens Forst. (a)
Disphyma australe (Forst. f.) Black. (i)
Doodia media R. Br. (c)
Echinopogon ovatus (Forst. f.) Beauv. (c)
Eleocharis acuta R. Br. (r)
Geniostoma ligustrifolium A. Cunn. (r-2)
Geranium dissectum L. var. *glabratum* Hook. f. (r)
Gnaphalium collinum Lab. (c)
Gnaphalium luteo-album Linn. (r)
Haloragis procumbens Cheesem. (c)
Hebe insularis (Cheesem.) Ckn. (i)
Hedycarya arborea Forst. (r-5)
Hiemerliodendron brunoniana (Endl.) Skottsb. (r-5)
Hydrocotyle americana Linn. (r)
Hydrocotyle novaezealandiae D. C. (c)
Hymenantha novaezealandiae (A. Cunn.) Hemsl. (i)
Juncus vaginatus R. Br. (r)
Lagenophora pumila (Forst. f.) Cheesem. (c)
Leptospermum ericoides A. Rich. (a)
Leptospermum scoparium Forst. (o)
Lilaeopsis novaezealandiae (Gandog.) Hill. (r)
Litsaea calicaris (A. Cunn.) Hook. f. (r)
Lobelia anceps Linn. (o)
Macropiper excelsum (Forst. f.) Miq. var. *major* Cheesem. (i-1)
Meliclytus ramiflorus Forst. (o)
Melicope ternata Forst. (o)



Three photographs from the eastern limb of Great Island.

Fig. 8. Kanuka (left) apparently replacing over-mature manuka (right).
(E. G. Turbott.)

Fig. 9. *Coprosma rhamnoides* growing beneath over-mature kanuka.

Fig. 10. Kanuka re-establishing itself in open glades formed by death of old specimens.

- Meryta Sinclairii* (Hook. f.) Seem. (i-1)
Metrosideros excelsa Gaertn. (o)
Metrosideros perforata (Forst.) Rich. (i)
Microrosorium diversifolium (Willd.) Copel. (r)
Microtis unifolia (Forst. f.) Reich. (c)
Muehlenbeckia complexa (A. Cunn.) Meissn. (o)
Myoporum laetum Forst. (o)
Olea apetala Vahl. (r-3)
Oplismenus undulatifolius Beauv. (c)
Oxalis corniculata Linn. (c)
Paratrophis Smithii Cheesem. (o)
Parietaria debilis Forst. (r)
Parsonsia heterophylla A. Cunn. (o)
Peperomia Urvilleana A. Rich. (i)
Phormium sp. (i)
Pimelia tomentosa (Forst.) Druce. (o)
Pittosporum Fairchildii Cheesem. (r-4)
Plantago Raoulii D.C. (o)
Plectomirtha baylisiana Oliver (r-1)
Poa anceps Forst. (i)
Poa seticulmis Petrie (o)
Pteridium esculentum (Forst. f.) Ckn. (o)
Pteris comans Forst. (o)
Pyrrosia serpens (Forst. f.) Ching. (o)
Ranunculus hirtus Forst. f. (c)
Rhagodia nutans R. Br. (r)
Salicornia australis Forst. f. (i)
Schizaea fistulosa Labill. (o)
Schœenus foliatus (Hook. f.) Blake (o)
Scirpus cernuus Vahl. (o)
Scirpus inundatus (R. Br.) Poir. (o)
Scirpus nodosus Rottm. (a)
Senecio lautus Forst. (o)
Sicyos angulata Linn. (r-1)
Sideroxylon novozelandicum (F. Muell.) Hemsl. (r-4)
Solanum nigrum L. (r)
* *Sonchus oleraceus* L. (r)
Spergularia marginata Kittel. (r)
Suttonia australis A. Rich. (r-1)
Suttonia dentata Oliver. (r-7)
* *Taraxacum officinale* Weber. (r)
Tecomanthe speciosa Oliver. (r-1)
Tetrapathaea tetrandra (D.C.) Cheesem. (o)
Tetragonia trigyna Hook. f. (i)
Thelymitra longifolia Forst. (o)
Vitex lucens T. Kirk. (r-2)
* *Vulpia dertonensis* (All.) Volk. (c)
Wahlenbergia gracilis (Forst. f.) Schrad. (a)
Zoisia matrella (Linn.) Merrill. (a)

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APPENDIX: GREAT ISLAND IN DECEMBER, 1947.

Through the kindness of Major M. E. Johnson, of the Yacht "Rosemary," I was able to spend in all about eighteen hours on Great Island at the end of December, 1947. It was possible to examine only part of the island in that time, but a collection was made which included:—

- (a) Ten species not previously recorded from Great Island, namely:
Agropyron Kirkii Zotov, *Cheilanthes Sieberi* Kunze, *Chenopodium triandrum* Forst. f., *Chloris truncata* R. Br., *Lepidium oleraceum* Forst. f., *Microlaena stipoides* R. Br., *Pelargonium inodorum* Willd., *Physalis peruviana* L., *Polypogon monspeliensis* (L.) Desf., *Pterostylis trullifolia* Hook. f.
- (b) Eight species recorded by earlier collectors (Oliver, 1948) but no longer apparent in 1945, namely: *Daucus glochidiata* (Lab.) Oliver, *Deyeuxia billardieri* Kunth., *Hypochoeris radicata* Lab., *Leucopogon fasciculatus* (Forst. f.) A. Rich., *L. Fraseri* A. Cunn., *Pteris tremula* R. Br., *Siegesbeckia orientalis* L., *Solanum aviculare* Forst. f.

It does not follow that the species listed above had very recently established or re-established themselves on the island. They could easily have escaped earlier observation if confined to inaccessible places or were very closely browsed. The most interesting phytogeographically is *Chloris truncata*, which formed several well-grown patches in the *Zoisia* area. It is an Australian grass, and if it is regarded as indigenous on the Three Kings it becomes an addition to the Australian element of our flora which is generally considered to have been carried here by the prevailing westerly winds (Oliver, 1935, Cockayne, 1928). As there would be little place for grasses in the primitive vegetation of the Group it seems more



Fig. 11. Kanuka prostrate scrub on the hillside south of Tasman Bay. Tussocks are *Scirpus nodosus*.

Fig. 12. *Zoisia* sward with tussocks of *Scirpus nodosus*.

Fig. 13. *Zoisia matrella* colonising bare ground on Bald Hill. The area is fringed with *Scirpus nodosus*.

likely, however, that it has become naturalised since the vegetation was disturbed. It is still necessary to invoke wind dispersal from Australia as the means of entry, since human intervention in the introduction of the seed, which is usually applicable to naturalised species (Allan, 1937), seems exceedingly doubtful in this case. The New Zealand mainland would be a necessary stage in seed transport by man, and here *C. truncata* is known only as a rarely grown ornamental (I am indebted to Dr. H. H. Allan and Mr. E. A. Madden for information on this point). We are probably provided therefore with an example of that renewal of natural plant immigration which Setchell (1935) considers likely to occur where man-made changes affect a climax vegetation. A study of the list of Australian species naturalised in North Auckland would probably reveal others.

Despite the short period that had elapsed since the goats were destroyed, changes were already apparent in the vegetation. Coastal herbs were colonising the areas of bare eroded soil, the largest, Bald Hill, being sparsely dotted with plants of the following (in order of frequency):—

Disphyma australe, *Chenopodium triandrum*, *Gnaphalium luteo-album*, *Cyperus ustulatus*, *Polygonum monspeliensis*, *Sonchus oleraceus*, *Senecio lantus*.

There had been no active spread of *Zoisia matrella*, previously the only plant growing on this area. The same species were present on the cliff screes at North West Bay, but *Sonchus oleraceus* was more plentiful and there was also much *Solanum nigrum* and fairly numerous small seedlings of *Myoporum laetum*. A few vines of *Sicyos angulata*, plentiful here at the time of Cheeseman's visit, had already reappeared.

Much of the *Zoisia* sward, despite its close texture, was abundantly studded with seedlings of kanuka (*Leptospermum ericoides*) as yet only a few inches in height, and the open moss-covered places among the kanuka in the drier parts of the island (Fig. 10) were also being colonised by *Leptospermum* seedlings. These, however, were often predominantly manuka (*L. scoparium*), notwithstanding the comparative scarcity of mature trees of that species. This observation is interesting in view of the evidence discussed earlier of past changes in the relative abundance of manuka and kanuka.

The sedges, which had been dominant on the floor of the kanuka forest where this is reasonably moist and well lit, were being overtopped in places by grasses (principally *Danthonia semiannularis*, *Deyeuxia crinita*, *Oplismenus undulatifolius* and *Echinopogon ovatus*) or by *Colensoa physaloides*, a tall soft herb that was already forming quite extensive patches. Small plants of *Arthropodium cirrhatum* were also often seen. Most significant, however, was the presence of well-grown seedlings of *Meryta sinclairii*, *Cordyline australis* and *Brachyglottis arborescens*, all of which were repeatedly observed in the valleys east of the Depot, in Castaway Valley itself, and occasionally in the lower Tasman Valley (unfortunately very little of the Tasman Valley system was explored). Less frequently seedlings were seen of the following:—

Litsaea calicaris, *Hiemerliodendron brunoniana*, *Melicope ternata*, *Meliccytus ramiflorus*, *Coprosma macrocarpa*, *Entelea arborescens*, *Pittosporum fairchildii*, *Geniostoma ligustrifolium*, *Tetrapathaea tetrandra*, *Clematis indivisa*.

The fact that *Meryta sinclairii* had established itself in quantity but nineteen months after removal of the goats calls for some comment. Since the species had not previously been recorded on Great Island (apart from the seedling seen in 1946) the seed must have come from adjacent islands. Major G. A. Buddle informs me that when he landed on South West Island he observed large numbers of red-billed gulls feeding greedily on the fruits of this tree. These are therefore likely to have been the chief agents of dispersal, the distance to be covered being only about a mile. The difficulty now is to account for the failure of *Meryta* to appear on Great Island in the interval between the departure of the Maoris and Cheeseman's visit if that was a period of unimpeded regeneration, as the evidence I have presented in the body of this paper suggests. I incline now to the view that the Maoris did in fact leave sufficient goats behind to prevent the re-establishment of *Meryta* by their selective browsing, but that they were not at first sufficient to prevent regeneration entirely.

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SUMMARY.

1. It is considered that before Maori settlement Great Island was covered by *Meryta* forest close to the sea, and by mixed coastal forest elsewhere. The latter would be dominated in more favourable situations by species common in coastal forests on the North Auckland mainland and its adjacent islands, but small locally-endemic trees, of which seven species are known, were probably among the dominants on stony soils and in exposed situations. Some were no doubt present also in taller forest as subdominants.

2. This vegetation was almost wholly destroyed by Maori settlers.

3. With the departure of the Maoris about 1840 forest regeneration began. It may have been impeded by a small goat population, since *Meryta* had not reappeared by 1889.

4. In 1889 four goats were landed. Subsequently goats became so numerous that the succession was soon halted, in most places at a sub-climax stage dominated by *Leptospermum ericoides*. However, part of the island was still in grassland dominated by *Zoisia matrella* in 1945. This area probably suffered the added disturbance of a fire early in the present century.

5. In 1946 all goats were destroyed, and by the end of 1947 seedlings of the climax dominants were already in evidence. These included *Meryta*, which must have been carried by birds from other islands of the Group.



Two photographs taken at the end of December, 1947.

14. Floor of kanuka forest in a gully near the head of South-east Bay. The large leaved plants comprise a seedling of *Meryta* (centre foreground), *Colensoa* and *Pteris comans*.
15. Seedlings of *Brachyglottis arborescens* beneath mature trees. The creeping herb is *Chenopodium triandrum*.

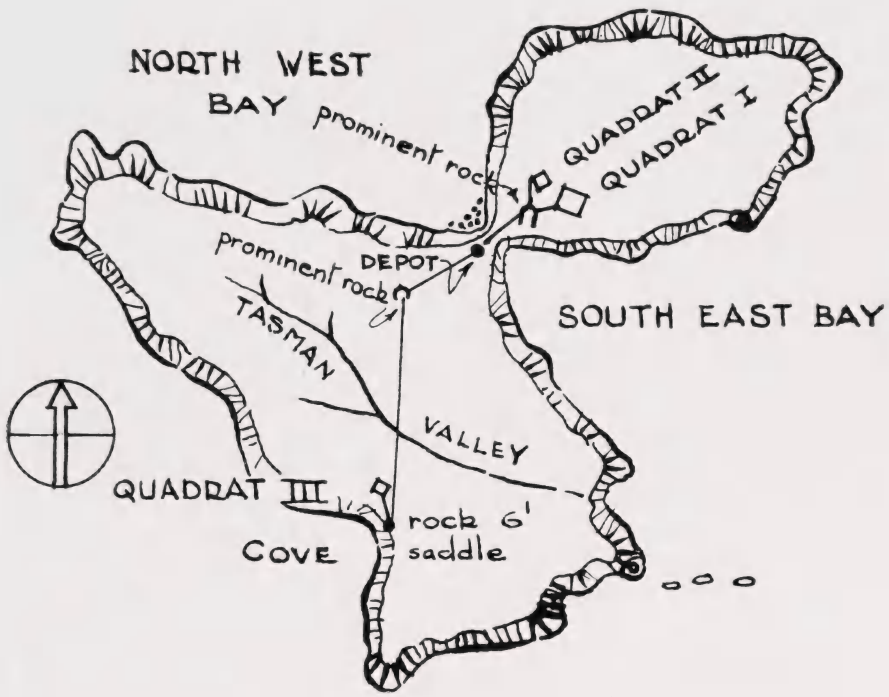


Fig. 1. Great Island, showing position of quadrats (not to scale).

Fig. 2. Tasman Valley from prominent rock to south-west of depot. Quadrat III is situated under cloud shadow approximately 95 yards from the lowest point (X) of the saddle above the south-western cove.